Global Hawk over Edwards Air Force Base.

DOD

Future Employment of UAVs

Issues of Jointness

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Unmanned aerial vehicles (UAVs) and their armed counterparts, uninhabited combat aerial vehicles (UCAVs), are poised to reshape the battlespace by either reducing or eliminating the need for manned aircraft in dangerous situations. How these systems are deployed—haphazardly or synergistically—will determine whether they are truly revolutionary or merely expensive toys. The simultaneous goals of increasing munitions lethality and reducing friendly casualties can be realized by UAVs, but the approach to developing and employing them must balance requirements of both the joint community and the services.

A variety of considerations portend a more sparsely populated battlespace. While generally supportive of recent military operations, the public is increasingly adverse to the risk of casualties and prefers to substitute technology for lives. As *Joint Vision 2010* makes clear, "The American people will continue to expect us to win in any engagement, but they will also expect us to be more efficient in protecting lives and resources. . . ." This expectation is one result of the Persian Gulf War and assumes that the Nation will leverage technological advances and precision weaponry

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to decisively defeat enemies without protracted conventional combat operations. Although this view is flawed, planners must limit both casualties and collateral damage.

Why UAVs?

One way to engage an enemy with minimum casualties is through the use of UAVs. They are the most visible members of the family of unmanned and autonomous systems either employed or under development. These powered aerial vehicles carry no human operators, use aerodynamic forces for lift, fly autonomously or are piloted remotely, are either expendable or recoverable, and carry both lethal and nonlethal payloads. But ballistic or semiballistic vehicles, cruise missiles, and artillery projectiles are not considered as unmanned vehicles. Often distinguished by their ability to deviate from a preordained flight path, UAVs respond to external command.

Unmanned systems have traditionally been employed in dirty and dangerous missions, and their development has proceeded along unique avenues of specialization. To date, their design has emphasized affordability, practicality (launch and maintenance), and recoverability. UAV missions in the past have included reconnaissance and surveillance, target acquisition, intelligence collection, and battle damage assessment. In the early 1960s, the Nation developed unmanned reconnaissance vehicles to overfly the Soviet Union because of the concern over the vulnerability of U–2 aircraft. UAVs were employed extensively for reconnaissance in Vietnam as well as to drop leaflets, collect signals intelligence, and support radar interference missions. They were rediscovered in the 1980s and gained prominence in the Persian Gulf War. The Army and Navy acquired Pioneer (a tactical UAV) to provide inexpensive, unmanned, over-the-horizon targeting, reconnaissance, and damage assessment. Six Pioneer systems (one Army, two Navy, and three Marine Corps) were deployed to Southwest Asia for Operation Desert Storm. They flew 330 sorties and logged more than 1,000 flight hours during the conflict. Together with the Air Force Predator, Pioneer also furnished real-time imagery of Bosnia for Implementation Force.

UAVs have proven their ability to provide near-real time reconnaissance and surveillance to commanders. They are tools for battle management, providing intelligence, and ultimately offering warfighters greater situational or battlespace awareness. They have proven effective in electronic combat support and battle damage assessment. Advanced technology is expanding these roles and, in the future, UAVs will act as airborne data links, enemy radar jammers, chemical and biological weapons detectors, target acquisition systems, and finally precision air attack systems.

Wreckage of Predator UAV, Bosnia.

55th Signal Company (Edward W. Nino)

The Next Generation

Development of a lethal platform capable of precision strikes is the logical progression for future UAVs. They will not be limited to support functions such as reconnaissance. Affordability, smaller size, and reduced training time are leading to a new class of systems—uninhabited combat aerial vehicles—which are smaller than their manned counterparts. And, without occupants, there is proportionally more room for munitions load in UCAVs. That benefit is most evident in carrier operations where they would occupy only one-third of the flight-deck space of comparable manned systems. Twenty very large, carrier-based support aircraft could be replaced by an equal number of very small support UCAVs. This would create enough extra space on the flight deck to increase mission-ready strike aircraft count by 33 percent (from 36 to 48 aircraft). Another option would be to place UCAVs on other ships, allowing for more strike aircraft space. Even more noteworthy is the concept that "20 support UAVs could

be replaced one-for-one with vertical take-off and landing strike UCAVs, bringing the number of mission-ready aircraft to 63, nearly doubling the strike aircraft availability of the baseline *Nimitz*-class carrier air wing configuration."[1]

The advocates of using UCAV in an precision air attack role routinely cite the potential of high-speed, highly maneuverable platforms to outperform manned aircraft. Airframe designers can gain flexibility and increase airframe performance when the limits imposed by human capacities are eliminated. Maximum G-force loading becomes a function of airframe structural integrity, not pilot limitations. In addition, cost and weight savings are realized through the elimination of canopies, ejection systems, oxygen systems, and other components required in manned combat aircraft.

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Fatigue is not a factor; remote pilots can be rapidly replaced. Extended flight times become possible, particularly if savings in weight make aircraft more efficient. One potential employment of UCAVs capitalizes on the ability to loiter for long periods. This concept, known as air occupation, is described as the capability to hold an enemy at risk from either lethal or nonlethal effects from the air. UCAVs could afford a nearly permanent presence over an enemy, providing a continuous stream of intelligence while simultaneously delivering a lethal payload in seconds.

One UCAV system being explored by the Defense Advanced Research Projects Agency as the Air Force Unmanned Combat Air Vehicle Advanced Technology Demonstration is intended to demonstrate the technical feasibility for a man-in-the-loop system. It will be designed to affordably suppress enemy air defense/strike missions in the next century within emerging global command and control architectures. It is envisioned that in the midterm UCAVs will serve as force enablers by suppressing enemy air defenses and performing punitive strike missions in support of manned aircraft. As concepts and technologies mature, UCAV roles and missions can be expanded.

Two primary development guidelines are mission effectiveness and affordability. UCAVs have the potential to significantly reduce acquisition as well as operation and support costs. They can be manufactured for an estimated one-third less than manned aircraft, and costs could be cut by 75 percent. Eliminating the pilot will allow manufacturers to take advantage of new technologies and designs to build smaller, more affordable systems. Lower operation and support costs can be achieved since it will no longer be necessary to maintain pilot proficiency. Simulators will allow UCAV controllers to train and maintain their skills.

The controller (man-in-the-loop) is key to UCAV development. "Human-system interface is critical in order to allow the mission control team the information and control methodology to efficiently operate multiple UCAVs in a dynamic battlespace."[2] The mission control station will be a

no credit

Unmanned surface vehicle.

Pioneer I RPV taking off from *USS Iowa*.

central component of the UCAV system. It will exercise command, control, and communications and conduct mission planning and execution, including targeting and battle damage assessments. To effectively accomplish this, the systems will take maximum advantage of on board and external intelligence assets. While UCAVs must be capable of self-defense and responding autonomously to pop-up threats, decisions to target and employ lethal weapons will be made by a mission control team. Simply stated, the rules of engagement will be controlled by humans, in part to mitigate the unsettling idea of uncontrolled aircraft deploying weapons autonomously.

The objective of UCAVs is not to eliminate the human factor but to locate the pilot outside the aircraft. Exploiting this technology will permit the development of more cost-effective systems capable of performing missions for which manned aircraft are either capable or appropriate. In the near future, UCAVs will not replace, but rather operate with, manned systems. Their capabilities and reusable platforms will fill the gap between cruise missiles and manned aircraft.

Some proponents urge developing a system that does not rely on precision-guided munitions but on the precision delivery of dumb bombs to cut costs. Precision delivery would suggest low-altitude flight, with aircraft security provided by both stealth characteristics and an ability to escape in high-G maneuvers that cannot be matched by manned aircraft. A single operator should be able to give orders to many UCAVs that would operate nearly autonomously, not through remote teleoperation. Links to off-board sensors, perhaps fielded by other UAVs, would provide data to adjust to last-minute battlespace changes.

UAVs have demonstrated their utility, albeit in support roles rather than frontline combat. They give the operational commander a reliable means of reconnaissance in an environment where space-based or high-altitude reconnaissance aircraft are ineffective because of weather conditions. Moreover, they can perform missions in circumstances where political sensitivities or combat risks preclude the introduction of U.S. military personnel.

A Joint Future?

While using unmanned systems in combat is not new, what will be new in the foreseeable future is how such systems are used. Simply possessing a given technology does not suffice to be truly revolutionary; aircraft carriers, for example, were in service well before the full implications of carrier warfare were realized. A truly innovative approach to employing a new system requires concurrent doctrinal, organizational, and technological changes that affect planning, equipping, and training military forces. Development of UAVs has proceeded along the lines of traditional

service roles and operating environments thereby building on core competencies.

Proposals for unmanned systems for air-to-air combat or air delivery of munitions have generally originated in the Air Force, while Navy systems are optimized for a maritime missions. Not every system must be joint. Each should be designed to perform specific missions well rather than a variety of tasks marginally. Cost savings are often lost when systems receive gold-plated add-ons during development, ostensibly to enhance capabilities. Yet the fact that the services have historically embarked on different courses concerning UAV research, development, and acquisition can hardly be considered an advantage. When service requirements converge—such as intelligence and reconnaissance capabilities—interservice compatibility is desirable. This reduces both research and development and acquisition costs, facilitates communication and information exchange, and simplifies command and control challenges. The question is whether one or two general-purpose systems can be developed that are capable of responding to an array of requirements.

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Jointness extends beyond procurement. Its goal is battlespace synergism. All components acting together have a greater effect than if they operate independently. And jointness is more than simply interoperability, though that is a vital start. Interoperability is generally related to hardware systems with common operating protocols. Jointness embraces doctrine, organizational structures, matériel, training, personnel management, and leadership development.

UAVs support several fundamentals of joint warfare iterated in Joint Pub 1, *Joint Warfare of the Armed Forces of the United States*. Unity of effort and the concentration of military power is achieved through multiaxis attacks by ground- and sea-based UCAVs operating in deconflicted airspace. Knowing your enemy—a major canon of warfare—is greatly enhanced by effective use of UAVs in surveillance and reconnaissance. Common-user interfaces for data dissemination will facilitate the flow of information to warfighters, regardless of their service. Joint mission planning will reduce duplication of effort, freeing UAV assets for other missions.

UAVs can give commanders greater freedom of action, another fundamental. The range of options available to commanders is enhanced by UAVs since missions can be undertaken that are highly risky for a manned approach. This ability to assume risk can also help commanders seize and maintain the initiative, keeping an enemy perpetually off balance.

A first step in developing protocols and doctrine to enable UAVs to meet the challenges of joint operations is the Tactical Control System, currently under development and testing. It will provide the common operating environment and shared protocols for the Air Force Predator, Army Hunter, and joint Outrider UAVs. Flight controls and payload commands will be standardized and the system will have five levels of scalable interaction, from receipt of retransmitted data through actual control over launch, recovery, flight, and payload.

Joint doctrine for UAVs is limited to tactics, techniques, and procedures that are applicable to systems in operation (that is, employed on the tactical level for surveillance and reconnaissance) and is found in Joint Pub 3–55.1, *Joint Tactics, Techniques, and Procedures for Unmanned Aerial Vehicles*. It is outdated and does not reflect the capabilities of current systems, much less those under development. It views UAVs solely as force multipliers or support vehicles. It also does not address UCAVs or more advanced surveillance craft.

Much must be done to develop joint doctrine for UAV operations. Common operating systems and shared protocols reduce development and procurement costs by providing economies of scale. Doctrine can reduce mutual interference and offer solutions to problems of information flow. Jointness should not extend to abandonment of traditional areas of responsibility. In sum, the advantages being sought in joint integration, including unity of effort and the concentration of military power at decisive points, should also guide the employment of unmanned systems.

However, an argument frequently leveled against jointness is that it overshadows legitimate approaches to innovation by individual services. Soldiers, sailors, marines, and airmen regard the battlespace from varied perspectives. It is not the aim of jointness to eliminate those perspectives, but rather to draw on their unique qualities to provide a synergistic, highly integrated, and seamless fighting mechanism. Joint Pub 3–55.1 makes that point explicit: "care must be taken to distinguish between distinct but related responsibilities in the two channels of authority to forces assigned to combatant commands. The military departments and services recruit, organize, train, equip, and provide forces for assignment to combatant commands and administer and support these forces." New UAV systems must be conceived, developed, and provided to the combatant commanders.

Innovation springs from competition among services for roles and missions, and ultimately for resources. Each service has proven successful at

Predator UAV.

innovation, and a healthy rivalry among them has been a catalyst. Thus the danger of overemphasizing joint culture is that it could limit thinking or result in groupthink. "The differentiation of service cultures is inevitable, bred by the physical environment in which soldiers, sailors, and airmen operate. It is also highly desirable."[3]

A joint activity should carefully analyze every proposal with the object of ensuring cross-service fertilization of ideas that will enhance interoperability and jointness in the resulting fielded systems. A single joint organization tasked to conceive and perform research and development on UAV platforms will result in fewer ideas for discovery and less innovation because it will tend to focus on a few concepts it feels are important. If each service has its own organization, more ideas are likely to surface. Obviously relieving the services of their role as providers and replacing them with a centralized joint organization would be harmful to creativity and ensure that UAVs remain in their present role of limited support.

Unmanned combat technology has arrived. It is not necessarily expensive or complicated. Potential enemies can use rudimentary systems asymmetrically—perhaps in concert with weapons of mass destruction—to threaten our forces. To maintain an advantage UAVs and UCAVs should be regarded as elements of a system. It is incumbent on the United States to take the lead in this area lest it falls prey to an enemy which can capitalize on technology more successfully. JFQ

NOTES

[1] Bruce W. Carmichael, "Strikestar 2025," *The DTIC Review,* vol. 4, no. 2 (September 1998), p. 1.

[2] Defense Advanced Research Projects Agency, "Unmanned Combat Aerial Vehicle (UCAV) Advanced Technology Demonstration Solicitation," March 9, 1998, p. 7.

[3] F.G. Hoffman, "Innovation Can Be Messy," *U.S. Naval Institute Proceedings*, vol. 124, no. 1 (January 1998), pp. 46–50.